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OUTCOME OF PEDIATRIC MISSILE HEAD INJURIES

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ABSTRACT

Introduction

Missile injuries have progressively increased in Iraq after 2003. These injuries are uncommon in children, but cause greater severity compared to other injuries.

Method

Fifty two patients with pediatric missile injuries (PMIs) admitted to Alsadre teaching hospital (Basrah neurosurgical center) from March 2006 to June 2014 were enrolled in this study.

Results

The patients' age ranged from 6 months-18 years with a male/ female ratio= 11:2.The patients were victims of roadside grenade attacks, terror explosions, haphazard fires between security forces and militants, or air firing on marriages and processions ceremony. Bullet injury accounted for 44% of the study group, whereas the rest of the PMIs were caused by fragments from blast injuries. In patients with a Glasgow Coma Score (GCS) of 3–8 there was a 50% mortality rate and none of the patients had a good outcome. In patients with a GCS score of 9–12 there was no mortality rate and 60% of the patients had a good outcome. There was one death in the group with GCS scores of 13-15. Pupillary abnormalities were seen in 7 cases. About 73% of the patients had a unihemispheric injury, 13.5% had intracerebral hemorrhage, 9.6% had midline shift in addition to a unihemispheric injury, whereas 3.8% had bihemispheric involvement. About 15.4% of the patients had motor weakness. Two of the motor weakness and 3 of non-motor weakness patients died. Sixteen patients (30.8%) had fits. Four patients of them died, while one patient died from the group who did not develop fits. Four patients (7.7%) had meningitis. Thirty-four patients (65.4%) had some psychological upsets.

Conclusions

PMIs do not differ significantly from other types of head injury as far as prognostic factors are concerned. In Iraq, the epidemiology of PMI is different from that in the West. Education, of the community on the risks of haphazard bullet injuries, is recommended and the government must show more power to avoid these wrong habits.

KEYWORDS: Pediatric Missile Injuries, Bad Outcome and Good Outcome

INTRODUCTION

- Missile-related injuries form a leading cause of death and these injurieshave progressively increased in Iraq after 2003.[1-2]
- Missile injuries are uncommon in children, but cause greater severity, need for major surgery, mortality, disability and costs compared to other types of injury. Although, they are uncommon, there is a large variation in the incidence of pediatric missile injuries between regions.[3]

- Pediatric missile injury has been the subject of severalpopulation-based epidemiologic studies from the mid-1980s through 2002.[4–8] More recent population-based research has been limited and focused exclusively on mortality[9-12] or was restricted to hospital-based samples.[13–15] Data from the National Violent Death Reporting System provide insight into the problem.[16]

METHODS

Eighteen year-old or younger fifty-two patients, with PMIs due to a bullet or fragments from a blast whom were admitted toAlsadre Teaching Hospital (the only Basrah Neurosurgical Center) between March 2006 and June 2014, were enrolledin this study regardless their neurological status.

Data were prospectively collected from 2006 onwards. Patients withassociated injuries, such as those of the chest, abdomen, spine, and long bones, which could contributeto a low neurological status by causing hemorrhagicshock or hypoxia, were excluded. This exclusion was consideredbecause we wanted to study only the aspect of head injurycaused by bullets or blast fragments.

Most of the patients were transportedby civilians;the interval between injury and admission variedfrom 30 to 180 minutes depending on the distance of thesite of injury from theCentre and direct or shifting from other hospitals.

Resuscitation was performed to all of the patients accordingto the advanced trauma life support guidelines; thenature of the resuscitation depended upon the clinicalstatus of the patient. After resuscitation, patients were assessedneurologically and those with a GCS score ≤ 8 were intubated (a postresuscitation GCS score was usedin further analysis). A head CT scan was obtained in all cases. After CT, patients were surgically treated depending on the nature of the injury(s).

Surgery consisted of decompressivecraniectomyand removal of necrotic brain, hematoma, debris,and bone fragments that were easily accessible. No attemptwas made to perform extensive debridement of themissile tract in the brain.Firstly, superficialdebridement and then duraplasty and scalp closurewere performed.

All the 52 patients received antibiotics (combination ofceftriaxone + ampiclox) along with phenytoin 5 mg/kg/day after administering a loading dose of 15 mg/kg.Osmotherapy with mannitol (1 g/kg/day in divided doses) was delivered to all the patients who had brain edema.Intracranial pressure monitoring was not done because of the unavailability of the equipment.

All surgeries were performed by neurosurgeons andnot by trauma surgeons. Outcome was followed-upusing the Glasgow Coma Scale from 6 months-6 years. The bad outcome groups included grades were as follows:5= death, 4= vegetative state, 3= severe disability butconscious and a good outcome groups: 2= minimal disability, and 1= good recovery.

All data were analyzed using SPSS 19 software. Predictorsof outcome were assessed using chi-square analysis, and then logistic regression analysis was used, a p-value < 0.05 takenas significant.

RESULTS

The demographic characteristics: The 52 patients included in our studyranged in age from 2 to 18 years, with a mean age of 10.1 years. There was no significant statistical association could be recognized between age and outcome (p= 0.13).The male/female ratio was 11:2 with a high male preponderance.

Mechanism of injury: all the children were victims of violence in which they had no role and victimsof roadside terrorsexplosions, haphazardfire of between security forces and militantsorFiring in the air as a habit after winning a football match, marriages and processions ceremony.Some children were injured while playing withunidentified objects found in grazing fields, which turnedout to be explosives. There were no instances ofsuicide or murder among the study population. Bullet injuriesaccounted for 44% of the study group, whereas the restof the PMIs were caused by fragments from blastinjuries. There was no significant difference in outcome betweenthe two groups (p= 0.15).

Clinical Factors

Glasgow Coma Score: In patients with ascore of 3–8 there was a 50% mortality rate and noneof the patients had a good outcome. In patientswith a GCS score of 9–12 there was no mortality and 60% of the patients had a good outcome.There wasone death in the group with GCS scores of 13-15(sudden onset of severe headache followed by status epilepticus and Brain CT scan showed multiple intraparanchiamal hemorrhage)otherwise the other patients hada good outcome (p= < 0.001).

Pupillary Status

Pupillary abnormalities were seenin 7 cases: anisocoria in 3 cases (5.8%) and dilatednonreactive pupils in 4cases (7.7%). All patients in the lattergroup died, while there was no mortality in the anisocoriagroup,but all patients had badoutcome. One patient died with normal pupils but the other 84.3% survived(p < 0.001).

Radiological Parameters: Computed tomographyscanning done to all the study population; 38 patients (73%) had a unihemisphericinjury, 7 patients (13.5%)hadintracerebral hemorrhage and 5 patients (9.6%) had midline shift in addition to a unihemispheric injury,whereas 2 (3.8%) had bihemispheric involvement.The bihemispheric involvement group followed by theintracerebral hemorrhage with midline shift group had significantly bad outcomeas compared to the unihemispheric injury group(p= 0.017).

Motor Weakness: There were 8 patients (15.4%) had motor weakness while 44 patients (84.6%) had no weakness. Two (25%) of the motor weakness patients died while 3 (6.8%) of non-motor weakness patients died (p= 0.001).

Complications

Seizure: Seizures had in 19% of patients with bad outcome groups as compared to 5.8% of patients in a good outcome groups (p= 0.001).

Meningitis: Four (7.7%) patients had meningitis. All of them treated and became well (p=0.45).

Hydrocephaly: Three patients(5.8%) had hydrocephaly. All of the patients underwent ventriculoperitoneal shunt. In one of them, external ventricular drain was done firstly, then after 7 months hydrocephaly developed and ventriculo-peritoneal shunt was done. There were no significant outcomes inpatientswho had hydrocephaly as compared to those none had hydrocephaly (p=0.08).

Psychological Upset: Thirty four patients (65.4%) had some psychological upset. All bad outcome groups (13 patients) had psychological upset while 21(40%) patients from a good outcome groups hadpsychological upset (p=0.02).

DISCUSSIONS

In studies from more developed countries, the most common cause of PMIs in children is homicide or suicide.Among the Iraqi population, there are some incidents occur to people being targeted by explosive device blasts or of bombs being planted in public places by terrorists. People in the present study were also injured during firing in the air as a habit after winning a football match, marriages and processions ceremony. Since the grenade attacks were carried out on security forces in the vicinity of residential quarters and market areas, there were cases of injuries caused by grenade fragments, which otherwise would not have been expected to occur in a civilian population. None of our patients reported lying down on hearing missiles or after a blast; all of them had run for safe shelter, which made them more susceptible to stray bullets. Perhaps this tendency to run explains the higher incidence of head injury in these children. If people are taught to lie down in these circumstances, then there may be a decrease in the incidence of head injury. Note that patients who were injured by bomb blasts and improvised explosive device blastswere excluded from this study because they had associatedinjuries other than head trauma.[39,40,41,42,43,44]

Age has been shown to have a varying effect on the outcomein different series. In some studies, with decreasingage, outcome was adversely affected,[35,19,20,36,37,38] whilein others, it was the opposite.11 In this studyno age group had a better outcome (p= 0.13).This reflected haphazard of PMI in the population.

By comparing mechanisms of injury, most of the reference bullet injury carry bad outcome than blast injury. [47,48,32,33] In this study there were no differences in the outcome in patients with bullet injuries as compared to the patients with injuries from grenade blast fragments (p=0.15).; a good outcome occurred in 34.6% of patients in the first group as compared to 40.4% in the latter. Thedifference documented in other studies may be the result of the fact that PMIs in children is homicide or suicide while accidental injury with far distances causes the bullet losses its high energy (E= ½[mv2]). This is same causes lead to the mortality rate 17.64%lower the others studies. Nelson and colleagues,[56] the mortality rate was 36%. InKaufman's study,[22] the survival rate was only 2%.

Sixteen patients (30%) with severely GCS at time of admission to hospital all of them had bad outcome as compared with 4 patients with moderate GCS had bad outcome and 1 patient with mild GCS died. The GCS score was documented to be the strongest predictor of outcome after head injury,[17-27] and this trend was seen in the current study group as well p value 0.001.

None of this study patient with fixed dilated pupils survived, and no patients with anisocoria had a good outcome as compared to 71% of the patients with normal pupils. Patients with normally reacting pupils had agood outcome than those with nonreactive pupils. Pupillary changes reflect the extent of brainstem compression, which has a significant effect on outcome.[29,31] A unilateral fixed dilated pupil is thought to be attributable to the third nerve compression, while bilateral dilation signifies disturbed brainstem function.[17,21,32,33,34]

Inthe bihemispheric injury, midline shift, and intracerebral hemorrhage had a good outcome 1.9%, 3.8%, and 5.8% respectively as compared to63.5% in the unilateral injury group. Thistrend is obviously due to involvement of the critical midlinestructures. Eisenberg et al.[45]reported that midline shift is a very strong predictor ofabnormal intracranial

pressure, and the risk of death isgreater if the midline shift is large. Conversely, the investigationsof Miller et al. demonstrated no or only apoor correlation between midline shift and intracranialpressure[46]. In intracerebralhemorrhage more damage to the brain insult as primary injury and/or swelling of brain due to edema causes damage to the neuron as a secondary injury. In this study there was a significant correlation between the bihemispheric injury, midline shift, and intracerebral hemorrhage and bad outcome. P value 0.017

Complications of PMI

Seizuresoccurred in 19% of patients with bad outcome groups as compared to 5.8% of patients a good outcome groups, so the fits is a statically significant factor (p=0.001).Seizures indicated injury to brain parenchyma and the formation ofgliotic scar tissue in the tract of the missile injury and considered as a risk factor in the most of the study sample.

Meningitis occurred in 4 patients; threepatients in a goodoutcome groups and one patient in the bad outcomegroups.In this study meningitis has not an additional risk factor for prognosis (p=0.46).This might be due to the low number of cases and its treatable disease. This is same causes lead to ahydrocephaly not a significant factor for prognosis (p=0.08) when it occurred in 3patients, two patients in a good come groups and one patient in the bad outcome groups. Kishor et alreported its incidence to be up to 15% among all patients with severe head injury. According to Zander and Foroglou[2], about 10% of patients in large sample of head injured patients with prolonged coma developed some degree of hydrocephalus.[55]

The wide spectrum of post-traumatic squealed presented by the victim of craniocerebral injury is impressive, and ranges from a comatose, purely vegetative akineticmutism to neurological syndromes of varying severity and mild personality disorders. The main organic cause of disability after a head injury is disturbance of mental capacity. This disturbance may occur at various levels of mental activity and may range from affection of well-established skills such as speech, reading, calculation and orientation, to disturbances of higher capacities such as memory, abstract

Thinking and reasoning.[49-55] In this study 34 patients (65.4%) had psychological upset includedall bad outcome groups (13 patients) and 21(40%) patients from a good outcome groups. There were psychological upsetconsidered statically a significant factor for bad prognosis (p=0.02).This might be due to wide damaging neurons and brain concussion when fall on ground after injuries.

CONCLUSIONS

- PMIs do not differ significantly from head injury in other age groups as far as prognostic factors are concerned.
- The GCS score was documented to be the strongest predictor of outcome after head injury and can addthree other strong predictors of outcome in could be diagnosed, these were pupillary abnormality, motor deficit and seizures.
- In the developing countries, the epidemiology of PMIis different from that in the West. Education of the community to word risk of haphazard bullet injuries is needed and the government must be more powerful to avoid these wrong habits.

REFERENCES

1. Zouris JM, Walker GJ, Dye J, Galarneau M. Wounding patterns for US marines and sailors during Operation Iraqi

Freedom, major combat phase. Mil Med. 2006;171:246–52. [PubMed]

2. Chambers LW, Rhee P, Baker BC, Perciballi J, Cubano M, Compeggie M, et al: Initial experience of US Marine Corps forward resuscitative surgical system during Operation Iraqi Freedom. Arch Surg 140:26–32, 2005
3. DiScala C, Sege R. Outcomes in children and young adults who are hospitalized for firearms-related injuries. Pediatrics. 2004; 113(5):1306–1312
4. Nance ML, Denysenko L, Durbin DR, BranasCC, Stafford PW, Schwab CW. The ruralurbancontinuum: variability in statewideserious firearm injuries in children andadolescents. Arch PediatrAdolesc Med.
5. 2002;156(8):781–785
6. Powell EC, Jovtis E, Tanz RR. Incidence andcircumstances of nonfatal firearm-relatedinjuries among children and adolescents.
7. Arch PediatrAdolesc Med. 2001;155(12):1364–1368
8. Roesler J, Ostercamp M. Pediatric firearminjury in Minnesota, 1998. Fatal and nonfatalfirearm injuries among Minnesotayouth.Minn Med. 2000;83(9):57–60
9. Zavoski RW, Lapidus GD, Lerer TJ, Banco LI.A population-based study of severe firearminjury among children and youth.Pediatrics.1995;96(2 pt 1):278–282
10. Dowd MD, Knapp JF, Fitzmaurice LS. Pediatricfirearm injuries, Kansas City, 1992:a population-based study. Pediatrics. 1994;94(6 pt 1):867–873
11. Sege RD, Kharasch S, Perron C, et al. Pediatricviolence-related injuries in Boston:results of a city-wide emergency departmentsurveillance program. Arch PediatrAdolesc Med. 2002;156(1):73–76
12. Cheng TL, Wright JL, Fields CB, et al. Violentinjuries among adolescents: declining morbidityand mortality in an urban population.
13. Ann Emerg Med. 2001;37(3):292–300
14. Nance ML, Carr BG, Kallan MJ, Branas CC,Wiebe DJ. Variation in pediatric and adolescentfirearm mortality rates in rural andurban US counties. Pediatrics. 2010;125(6):1112–1118
15. Kegler SR, Annest JL, Kresnow M, Mercy J; Centers for Disease Control and Prevention(CDC). Violence-related firearm deathsamong residents of metropolitan areas andcities—United States, 2006–2007. MMWRMorb Mortal Wkly Rep. 2011;60(18):573–578
16. Martin CA, Unni P, Landman MP, et al. Racedisparities in firearm injuries and outcomesamong Tennessee children. JPediatr Surg. 2012;47(6):1196–1203
17. Schecter SC, Betts J, Schecter WP, VictorinoGP. Pediatric penetrating trauma: the epidemiccontinues. J Trauma Acute CareSurg. 2012;73:721–725
18. Senger C, Keijzer R, Smith G, MuenstererOJ. Pediatric firearm injuries: a 10-yearsingle-center experience of 194 patients. JPediatr Surg. 2011;46(5):927–932

19. Hernesniemi J: Penetrating craniocerebralmissile wounds in civilians. ActaNeurochir (Wien) 49:199–205, 1979
20. Bruce DA, Raphaely RC, Goldberg AI, Zimmerman RA, Bilaniuk LT, Schut L, et al: Pathophysiology, treatment and outcome following severe head injury in children. Childs Brain 5:174–191, 1979
21. Bruce DA, Schut L, Bruno LA, Wood JH, Sutton LN: Outcome following severe head injuries in children. J Neurosurg 48:679–688, 1978
22. Humphreys RP: Outcome of severe head injury in children, in Raimondi AJ (ed): Concepts in Pediatric Neurosurgery. Basel: Karger, 1983, Vol 3, pp 191–201
23. Cernak I, Wang Z, Jiang J, Bian X, Savic J: Ultrastructural and functional characteristics of blast injury-induced neurotrauma. J Trauma 50:695–706, 2001
24. Krieger D, Adams HP, Schwarz S, Rieke K, Aschoff A, Hacke W: Prognostic and clinical relevance of pupillary responses, intracranial pressure monitoring, and brainstem auditory evoked potentials in comatose patients with acute supratentorial mass lesions. Crit Care Med 21:1944–1950, 1993
25. Langfitt TW, Gennarelli TA: Can the outcome from head injury be improved? J Neurosurg 56:19–25, 1982
26. Levy ML: Outcome prediction following penetrating craniocerebral
27. injury in a civilian population: aggressive surgical management in patients with admission Glasgow Coma Scale scores of 6 to 15. Neurosurg Focus 8(1):e2, 2000
28. Mayer T, Walker ML: Emergency intracranial pressure monitoring
29. in pediatrics: management of the acute coma of brain insult. ClinPediatr (Phila) 21:391–396, 1982
30. Miller JD, Butterworth JF, Gudeman SK, Faulkner JE, Choi SC, Selhorst JB, et al: Further experience in the management of severe head injury. J Neurosurg 54:289–299, 1981
31. Sherman WD, Apuzzo ML, Heiden JS, Petersons VT, Weiss MH: Missile wounds to the brain—a civilian experience. West J Med 132:99–105, 1980
32. Taylor A, Butt W, Rosenfeld J, Shann F, Ditchfield M, Lewis E, et al: A randomized trial of very early decompressivecraniectomy in children with traumatic brain injury and sustained intracranial hypertension. Childs NervSyst 17:154–162, 2001
33. Clusmann H, Schaller C, Schramm J: Fixed and dilated pupils after trauma, stroke, and previous intracranial surgery: management and outcome. J NeurolNeurosurg Psychiatry 71: 175–181, 2001
34. Comninos SC: Early prognosis of severe head injuries in children.
35. ActaNeurochirSuppl (Wien) 28:144–147, 1979
36. Zuccarello M, Facco E, Zampieri P, Zanardi L, Andrioli GC: Severe head injury in children: early prognosis and outcome. Childs NervSyst1:158–162, 1985
37. Ropper AH: The opposite pupil in herniation. Neurology 40:1707–1709, 199032. Mazza C, Pasqualin A, Feriotti G, DaPian R: Traumatic extraduralhaematomas in children: experience with 62 cases. ActaNeurochir (Wien)

65:67–80, 1982

38. Liebenberg WA, Demetriades AK, Hankins M, Hardwidge C, Hartzenberg BH: Penetrating civilian craniocerebralmissile wounds: a protocol of delayed surgery. Neurosurgery 57:293–299, 2005
39. Michaud LJ, Rivara FP, Grady MS, Reay DT: Predictors of survival and severity of disability after severe brain injury in children. Neurosurgery 31:254–264, 1992
40. Luerssen T, Klauber MR, Marshall LF: Outcome from head injury related to patient's age. A longitudinal prospective study of adult and pediatric head injury.J Neurosurg 68:409–416, 1988
41. DePalma RG, Burris DG, Champion HR, Hodgson MJ: Blast injuries. N Engl J Med 352:1335–1342, 2005
42. Dhellemmes P, Lejeune JP, Christiaens JL, Combelles G: Traumatic
43. extradural hematomas in infancy and childhood. Experience with 144 cases.J Neurosurg 62:861–864, 1985
44. Pfenninger J, Kaiser G, Lütschg J, Sutter M: Treatment and outcome of the severely head injured child. Intensive Care Med 9:13–16, 1983
45. Raimondi AJ, Samuelson GH: Craniocerebralmissile wounds in civilian practice. J Neurosurg 32:647–653, 1970
46. Eisenberg HM, Gary HE Jr, Aldrich EF, Saydjari C, Turner B, Foulkes MA, et al: Initial CT findings in 753 patients with severe head injury. A report from the NIH Traumatic Coma Data Bank.J Neurosurg 73:688–698, 1990
47. Gutierrez FA, McLone DG, Raimondi AJ: Epidural hematomas in infancy and childhood, in American Society for Pediatric Neurosurgery (eds): Concepts in Pediatric Neurosurgery. Basel: Karger, 1981, Vol 1, pp 188–201
48. Jagannathan J, Okonkwo DO, Dumont AS, Ahmed H, Bahari A, Prevedello DM, et al: Outcome following decompressivecraniectomy in children with severe traumatic brain injury: a 10-year single-center experience with long-term follow up. J Neurosurg 106 (4 Suppl):268–275, 2007
49. Nelson TJ, Wall DB, Stedje-Larsen ET, Clark RT, Chambers LW, Bohman HR: Predictors of mortality in close proximity blast injuries during Operation Iraqi Freedom. J Am CollSurg 202:418–422, 2006
50. Peleg K, Aharonson-Daniel L, Michael M, ShapiraSC : Patterns of injury in hospitalized terrorist victims. Am J Emerg Med 21:258–262, 2003
51. Rodoplu U, Arnold JL, Tokyay R, Ersoy G, Cetiner S, Yücel T: Mass-casualty terrorist bombings in Istanbul, Turkey, November 2003: 45. Raimondi AJ, Hirschauer J: Head injury in the infant and toddler.
52. Coma scoring and outcome scale. Childs Brain 11:12– 35, 1984
53. Miller JD, Becker DP, Ward JD, Sullivan HG, Adams WE, Rosner MJ: Significance of intracranial hypertension in severe head injury. J Neurosurg 47:503–516, 197747. Jandial R, Reichwage B, Levy M, Duenas V, Sturdivan L: Ballistics
54. for the neurosurgeon. Neurosurgery 62:472–480, 2008
55. Jennett B, Teasdale G, Braakman R, Minderhoud J, Knill- Jones R: Predicting outcome in individual patients after

severe head injury. Lancet 1:1031–1034, 1976

56. Kluger Y: Bomb explosions in acts of terrorism—detonation, wound ballistics, triage and medical concerns. Isr Med Assoc J 5:235–240, 2003
57. Kaufman HH: Civilian missile wounds to the head. Neurosurgery
58. 32:962–964, 1993
59. Kaufman HH, Levy ML, Stone JL, Masri LS, Lichtor T, Lavine SD, et al: Patients with Glasgow Coma Scale 3, 4, 5 after missile wounds to the brain. NeurosurgClin N Am 6: 701–714, 1995
60. Hubschmann O, Shapiro K, Baden M, Shulman K: Craniocerebral
61. missile injuries in civilian practice—prognostic criteria and surgical management: experience with 82 cases. J Trauma 19:6–12, 1979
62. Lillard PL: Five year experience with penetrating craniocerebral
63. missile wounds. SurgNeurol 9:79–83, 1978 53. Miner ME, Cabrera JA, Ford E, Ewing-Cobbs L, Amling J: Intracranial penetration due to BB air rifle injuries. Neurosurgery 19:952–954, 1986
64. 57. Kishor PRS, Lipper MH, Miller JD, Girevendulis AK, Becker DP, Vines FS.Post-traumatic hydrocephalus in patients with severe head injury.Neuroradiology 1978; 16:261-5.
65. Kaufman HH, Schwab K, Salazar AM: A national survey of neurosurgical care for penetrating head injury. SurgNeurol 36:370–377, 1991
66. Kunze E, Meixensberger J, Janka M, Sörensen N, Roosen K: Decompressivecraniectomy in patients with uncontrollable intracranial
67. hypertension. ActaNeurochirSuppl 71:16–18, 1998
68. Levy ML, Masri LS, Lavine S, Apuzzo MLJ: Outcome prediction
69. after penetrating craniocerebral injury in a civilian population: aggressive surgical management in patients with admission Glasgow Coma Scale scores of 3, 4, or 5. Neurosurgery 35:77–85, 1994
70. Levy ML, Masri LS, Levy KM, Johnson FL, Martin-Thomson E, Couldwell WT, et al: Penetrating craniocerebral injury resultant from missile wounds: gang-related injury in children and adolescents. Neurosurgery 33:1018–1025, 1993
71. Polin RS, Shaffrey ME, Bogaev CA, Tisdale NRN, GermansonT, Bocchicchio B, et al: Decompressivebifrontalcraniectomyin the treatment of severe refractory posttraumaticcerebral edema. Neurosurgery 41:84–94, 1997
72. Sahuquillo J, Arikan F: Decompressivecraniectomy for thetreatment of refractory high intracranial pressure in traumaticbrain injury. Cochrane Database Syst Rev 25:CD003983,2006
73. Teasdale G, Parker L, Murray G, Knill-Jones R, Jennett B:Predicting the outcome of individual patients in the firstweek after severe head injury. ActaNeurochirSuppl (Wien)28:161–164, 1979